Chemicals in Lab Sump

Hydrocarbon Reagents

1,2-dichloroethane-d4	Isopropanol
1,4-dichlorobenzene-d4	Isopropyl benzene
2-Propanol	Methanol
4-bromoflourobenzene	methyl ethyl ketone
5-choloro-tricholoromethyl pyridine	methyl isobutyl ketone
80% iso-oct/20% n heptanes	Mineral Oil
acetone	MTBE
acetonitrile	naphthalene
Benzene	n-butanol
BOD Nutrient buffer	n-butyl benzene
chlorobenzene-d5	n-decane
cyclohexane	n-heptane
cyclopentane	n-nonane
ETBE	neo hexane
ethanol	oil & grease standard
ethylbenzene	pentane
flourobenzene	Petroleum Ether
Heptanes	pH buffer kit
hexadecane	potassium hydroxide
hexane	propylene glycol
hydranal coulomat'	silicon bath oil
iso amyl alcohol	silver nitrate
isobutyl alcohol	sulfolane
Iso-octane	synthetic pump oil

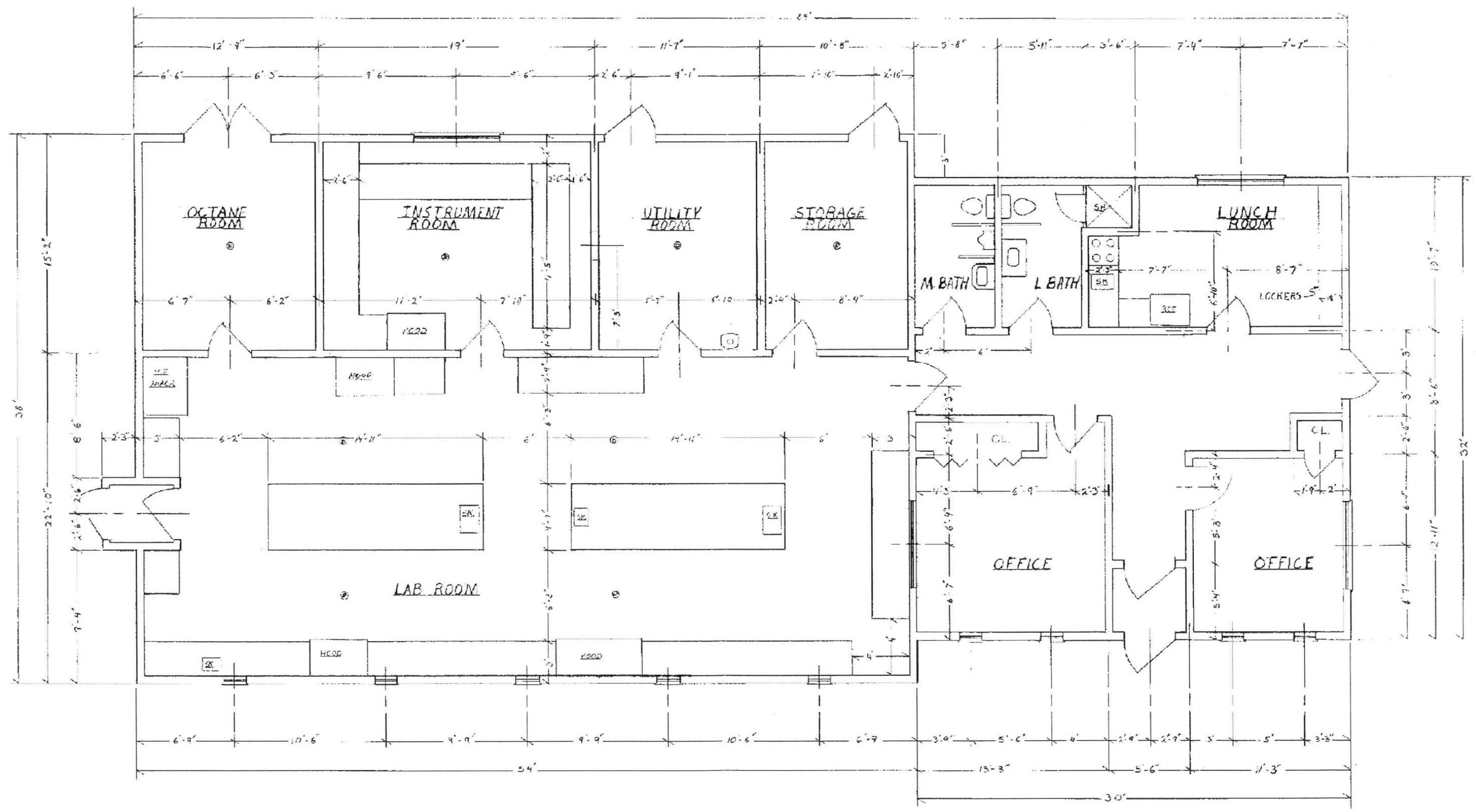
Other Reagents

1,10-phenanthroline-p-toluene sulfonic acid salt	polyvinyl alcohol
12-hydroxystearic acid	potassium bi-iodate
2-chloro-6-(trichloromethyl)pyridine	potassium chloride solution
4,5-dihydroxy-2,7-naphthalenedisulfonic acid, disodium salt	potassium dichromate
4-aminoantipyine	potassium ferricyanide
4-aminoantipyrine phosphate	potassium hydrogen phthalate
acetic acid	potassium hydroxide
acetonitrile	potassium iodide
alkali iodine azide solution	potassium nitrate
aminomethylpropanol	potassium nitrite
Ammonium chloride	potassium oxalate
Ammonium hydroxide	potassium permanganate
Aniline	potassium phosphate, dibasic
ascorbic acid	potassium phosphate, monobasic
asino ethylpropanol	potassium pyrosulfate

Chemicals in Lab Sump	
Barium Chloride	potassium sodium tartrate
boric acid	potassium sulfate
Bromine	proprionic acid
Buffer solution pH10	SALT FOR DEICING AND WATER SOFTENERS
Buffer solution pH4	silica gel
Buffer solution pH7	silver chloride
cadmium	silver nitrate
calcium chloride	silver sulfate
calmagite	sodium acetate
Carbon Disulfide	sodium azide
CDTA trisodium salt	sodium bicarbonate
chloroform	sodium borate
chromium trioxide	sodium carbonate
citric acid	sodium chloride
Cupric Carbonate, basic	sodium gluconate
Cupric Nitrate	sodium hydrosulfite
dextrose	sodium hydroxide
diethanolamine hydrochloride	sodium iodide
DIETHYLENE GLYCOL MONOMETHYL ETHER (FSII)	sodium metabisulfite
dilute hydrochloric acid	sodium molybdate
Dilute Nitric Acid	sodium phosphate
dilute sulfuric acid	sodium Plumbite
diphenylcarbazone indicator	sodium sulfanilate
EDTA	sodium sulfate
ferrous ammonium sulfate	sodium sulfide
ferrous chloride	sodium sulfite
ferrous sulfate	sodium tartrate
formaldehyde	sodium thiosulfate
gentisic acid	Stadis 450
Glutamic Acid	starch indicator
glycerine	sulfanilic acid
hydrogen peroxide	sulfur
iodine	talc
iodine monochloride	tartaric acid
lithium chloride	trichoro-triflouro ethane
lithium hydroxide	various mineral salts
lithium nitrate	t-amyl alcohol
magnesium sulfate	tetrahydronaphthalene
Manganese Nitrate	tetramethylbenzenes
mercuric iodide	Toluene
Mercuric Nitrate	Toluene-d8
mercuric sulfate	trichloroethylene (slight possible)

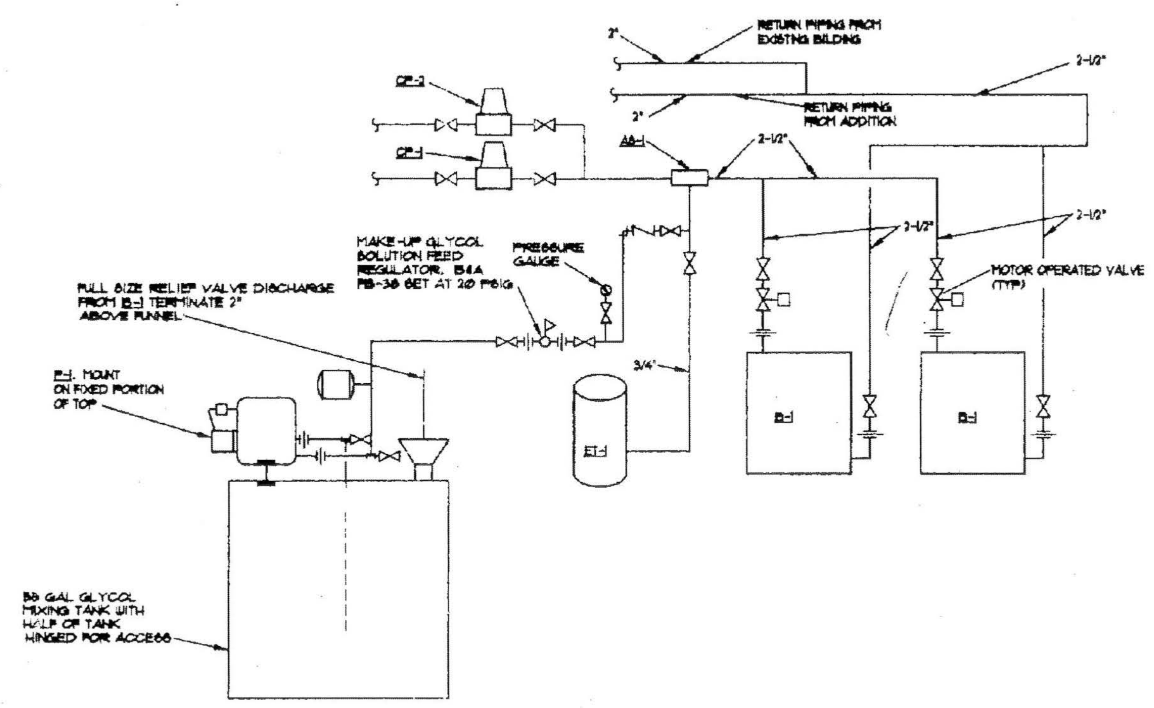
Chemicals in Lab Sump	
METHYL CARBITOL SOLVENT (FSII)	trimethylbenzenes
naphtholbenzein	vacuum pump oil
phenol	Viscosity bath oil
phenolphthalein	water standard
phosphate buffer solution	xylenes
phosphoric acid	* (30-60% methanol,10-20% 1-pentanol, 5-15% imadazole, 5-25% dodecyldimethylamine)
Hydrocarbon Samples	
ARC	HVY Kero
Asphalt	Incoming Crude
ASPHALT DEFOAMER	JP-4
BRT bottoms	JP-8
BRT feed	Kero raffinate
BRT ovhd	Kero recycle
Combined Return crude	LAGO
cooling kero	LSR
COREXIT 307 CORROSION INHIBITOR	LT Kero
CU1 stabilizer	LUBRIZOL 8195 GASOLINE ADDITIVE
Deprop bottoms	MDEA
Deprop feed	MONOETHANOL AMINE (MEA)
Desalted Crude	MORLIFE 5000 ASPHALT ADDITIVE
ETHYL ANTIOXIDANT 733 MDA 80	N Kero
ETHYL ANTIOXIDANT 733 PDA (D) 25	Naphtha
F-76	Naphtha raffinate
FHR Return Crude	Naphtha recycle
Full Kero	propylene glycol
Gasoline (unleaded)	S Kero,
HAGO	sulfolane
HITECH 6423 FUEL ADDITIVE	VGO
HITECH 6531 FUEL ADDITIVE	
Waters - samples & other	
Desalter Water	Effluent wastewater
Crude OVHD water	Influent wastewater
C1 Stabilizer ovhd water	Gravel pit water
Deprop ovhd water	Gallery Pond water
Vacuum ovhd water	Fire water
BRT ovhd water	Cooling water for Octane Engines
Recovery ovhd water	Ice machine water
Benzene stripper	HVAC condensate
Boiler water	Deionizer condensate
Kero stripper ovhd water	Cooling water for Bomb Calorimeter

Chemicals in Lab Sump	
Cooling water for boiler	
NALCO Chemicals	
NALclean 8940	Nalco EC 5816A
NALclean 8960	Nalco EC 5828A
Nalco 5376	Nalco EC 5830A
Nalco 5403	Nalco EC2043a
Nalco 5541	Nalco EC5345A
Nalco 5541	Nalco EC5370A
Nalco 5602	Nalco EC5407A
Nalco 7320	Nalco SO771 indicator
Nalco 8735	Nalco SO771 N-2 Titrant
Nalco EC 5419A	Nalco SO780MQT-1
Detergents & cleaners	
409	Janitorial chemicals
A-33 Dry respirator cleaner	Joy
alcojet	neodisher A8
alcotabs	neodisher EM
citrus degreaser	neodisher N
Clorox	neodisher Z
Contrad 70	RBS solution
Contrex	Windex



NEW LAB FLOOR PLAN

FLOOR PLAN		
SCALE: 1/4 = 1'-0"	APPROVED BY:	DRAWN BY HUNLEY
DATE.		REVISED
		DRAWING NUMBER 11B-2



1 / M-1 BOILER PIPING SCHEMATIC
NO SCALE

EQUIPMENT SCHEDULE

SYMBOL	ITEM	CAPACITY/SIZE	HP	ELEC.	MANUFACTURER & MODEL	REMARKS
B-1	BOILER	664 MBH GROSS OUTPUT, 5.5 GPH FIRING ON NO. 2 FUEL OIL	1/8	115/1/60 3A	BURNHAM MODEL V-906	
AS-1	AIR SEPARATOR	2-1/2"	---	------	TACO MODEL 435	
ET-1	EXPANSION TANK	21 GALLON VOLUME, 10 GALLON ACCEPTANCE VOLUME	---	------	AMTROL MODEL SX-40V EXTROL	PRESSURIZE TO 6 PSIG
CP-1	CIRCULATING PUMP	40 GPM @ 18 FT. TDH	1/6 1/3	115/1/60 7.2	GRUNDFOS MODEL UMC 50-80, RUN ON SPD. 3	
CP-2	CIRCULATING PUMP	45 GPM @ 15 FT. TDH	1/6 1/2	115/1/60 7.2	GRUNDFOS MODEL UMC 50-80	
P-1	GLYCOL MAKE-UP PUMP	690 GPH @ 20 PSIG	1/3 1/3	115/1/60 7.2	GOULDS MODEL J03WS AQUA-AIR	
UH-1	UNIT HEATER	43.5 MBH, 180° EWT, 20° TEMP. DROP, 4.5 GPM, 0.15 FT. WPD	1/6 1/8	115/1/60 3A	DUNHAM BUSH MODEL H300C	
FTR-1	FINNED TUBE RADIATION	1060 BTUH/LF @ 180° AWT	---	------	DUNHAM BUSH MODEL 640 WITH 18H4X4-48 ELEMENT	
AHU-1	AIR HANDLER	2345 CFM @ 1.8" SP	2 2	208/3/60 7.5	McQUAY MODEL CAH006FDAC WITH FLAT FILTERS, MIXING BOX, HTG AND CLG COIL, INTERNALLY ISOLATED	
HC-1	HEATING COIL	2345 CFM, 0 TO 85 WITH 21.4 GPM, 180° EWT, 20 °TEMP DROP, 0.13" APD, 2.7 FT. WPD	---	------	McQUAY MODEL 5WH1002B, LOCATED IN AHU-1	
CC-1	COOLING COIL	2345 CFM, 80/62 WB EAT, 55 ° LAT, 40° SUCTION TEMP	---	------	McQUAY MODEL 5EN0504B, LOCATED IN AHU-1	
PHC-1	PREHEAT COIL	2345 CFM, -60° TO 0° WITH 11.5 GPM, 180° EWT, 30° TEMP DROP 0.06" APD, 0.5 FT. WPD	---	------	McQUAY MODEL 5WQ0901H, SIZE 30x24	
CU-1	CONDENSING UNIT	7.5 TONS COOLING	27.7 AMP	208/3/60	YORK MODEL H1D076	
VF-1	VENTILATING FAN	1000 CFM @ 0.25" SP	1/8	115/1/60	PENN P&T PROPELLER FAN WITH MOTORIZED DAMPER, WALL SLEEVE, REAR GUARD	
L-1	LOUVER	SIZE AS INDICATED ON PLANS	---	------	RUSKIN MODEL ELF375D	
BD-1	BAROMETRIC DAMPER	SIZE AS INDICATED ON PLANS	---	------	RUSKIN MODEL BDG WITH STATIC PRESSURE CONTROL AND REAR SCREEN	
CV-1	PHC-1 CONTROL VALVE	2 WAY VALVE, CV=16	---	------		
CV-2	HC-1 CONTROL VALVE	2-WAY VALVE, CV=10	---	------		

SEQUENCE OF OPERATION

1. BOILER B-1 SHALL OPERATE IN ACCORDANCE WITH ITS PACKAGED CONTROL SYSTEM. THE BOILERS SHALL RUN IN A LEAD-LAG MODE, WITH THE SECOND BOILER OPERATING WHENEVER THE FIRST BOILER IS NOT ABLE TO MAINTAIN WATER TEMPERATURE. ALTERNATE LEAD-LAG FIRING ON EACH START. TWO POSITION CONTROL VALVE ASSOCIATED WITH EACH BOILER SHALL CLOSE WHEN LAG BOILER IS NOT RUNNING.
2. CIRCULATING PUMP CP-1 SHALL RUN WHENEVER THE OUTSIDE TEMPERATURE IS BELOW 60 DEGREES F.
3. CIRCULATING PUMP CP-2 CONTROLS SIMILAR TO CP-1.
4. AIR HANDLING UNIT AHU-1 SHALL RUN CONTINUOUSLY. PREHEAT COIL CONTROL VALVE, CV-1, SHALL MODULATE TO MAINTAIN LEAVING AIR TEMPERATURE OF 0 DEGREES F. THE MIXING DAMPERS SHALL MODULATE TO MAINTAIN BUILDING STATIC PRESSURE OF 0.01 INCHES. IN ADDITION, HEATING COIL HC-1 CONTROL VALVE CV-2 AND THE MIXING DAMPERS SHALL MODULATE IN SEQUENCE TO MAINTAIN ROOM AIR TEMPERATURE, SET POINT 70 DEGREES F. RELIEF DAMPER SHALL MODULATE OPEN WHENEVER THE BUILDING PRESSURE RISES ABOVE 0.05 INCHES.
5. CONDENSING UNIT CU-1 CONTROL SYSTEM SHALL BE ACTIVATED WHENEVER THE OUTSIDE AIR TEMPERATURE IS ABOVE 55 DEGREES.
6. EXHAUST HOOD SHALL RUN FROM MANUAL SWITCH LOCATED ADJACENT TO HOOD.
7. PUMP P-1 SHALL RUN TO MAINTAIN HYDRONIC SYSTEM PRESSURE AS DETERMINED BY PUMP PRESSURE SWITCH.
8. FINNED TUBE RADIATION ZONE VALVE SHALL CYCLE OPEN ON CALL FOR HEAT AS DETERMINED BY ROOM THERMOSTAT.
9. UNIT HEATER UH-1 FAN SHALL RUN ON A CALL FOR HEAT FROM THE ROOM THERMOSTAT. SET POINT 70 DEGREES. CONTINUOUS FLUID FLOW THROUGH UNIT HEATER.
10. VENTILATION FAN VF-1 SHALL RUN AND DAMPER SHALL OPEN ON CALL FOR COOLING FROM ROOM THERMOSTAT. SET POINT 75 DEGREES.

11 UH1 IS CONTROLLED FROM 120V LINE THERMOSTAT
VF1 IS CONTROLLED OFF SAME THERMOSTAT
FOR COOLING MECHANICAL ROOM.

SPECIFICATIONS

1. FURNISH ALL EQUIPMENT, MATERIAL AND LABOR TO PROVIDE COMPLETE AND OPERATING MECHANICAL SYSTEMS.
2. ALL WORK TO BE DONE IN ACCORDANCE WITH LATEST EDITION OF UFC, UBC, UMC, ADEC, SMACNA, ASHRAE AS APPLICABLE.
3. ALL ELECTRIC MOTORS AND STARTERS SHALL BE U.L. LISTED AND BEAR THE UL SEAL. MOTOR STARTERS SHALL BE FURNISHED BY THE MECHANICAL CONTRACTOR.
4. PERFORM AIR AND WATER BALANCE ON VENTILATION AND HYDRONIC SYSTEMS TO WITHIN 10% OF DESIGN CRITERIA AND PROVIDE A COMPLETE BALANCE REPORT FOR ENGINEER'S REVIEW.
5. DOMESTIC WASTE AND VENT PIPING BELOW GRADE SHALL BE STANDARD WEIGHT HUB AND SPIGOT CAST IRON PIPE WITH "TYSEAL" JOINTS OR NO-HUB CAST IRON PIPE WITH NEOPRENE COLLAR AND STAINLESS STEEL BAND, AND SHALL BE INSTALLED IN ACCORDANCE WITH UNIFORM PLUMBING CODE. ALL WASTE AND VENT PIPING ABOVE GRADE SHALL BE TYPE DWV COPPER TUBING.
6. ALL OILY WASTE PIPING BELOW GRADE SHALL BE BLACK SCH. 40 PIPE WITH WELD FITTINGS AND WELDED JOINTS IN ACCORDANCE WITH ADEC REQUIREMENTS AND QW-302.3 SECTION IX, ASME BOILER AND PRESSURE VESSEL CODE. VENT PIPING FOR OILY WASTE SYSTEM SHALL BE CAST IRON PIPE AND FITTINGS WITH NO-HUB FITTINGS AND COUPLINGS. OILY WASTE SHALL BE WRAPPED WITH HEAT TAPE AND ~~CATHODICALLY~~ PROTECTED. AT SUMP
7. COPPER TUBING FOR FUEL OIL PIPING BELOW GRADE SHALL BE TYPE 'K' SOFT DRAWN TUBING WITH FLARE FITTINGS OR WROT COPPER FITTINGS AND 1000 F SILVER SOLDER JOINTS.
8. COPPER TUBING FOR DOMESTIC WATER SYSTEMS SHALL BE TYPE 'L' HARD DRAWN TUBING WITH WROT COPPER FITTINGS AND 95-5 SOLDER JOINTS.
9. HEATING PIPING SHALL BE TYPE 'L' HARD DRAWN COPPER WITH WROT COPPER FITTINGS AND 95-5 SOLDER JOINTS.
10. INSULATE HOT AND COLD DOMESTIC WATER LINES AND HEATING WATER LINES WITH 1" THICK FIBERGLASS INSULATION WITH VAPOR BARRIER JACKET.
11. INSULATE ALL OUTSIDE AIR INTAKE DUCTS WITH 3" THICK, 3 LB. DENSITY RIGID FIBERGLASS. INSULATE EXHAUST DUCTS WITH 1" THICK RIGID FIBERGLASS. ALL DUCT INSULATION SHALL HAVE FSK JACKET.
12. HYDRONIC HEATING SYSTEM SHALL BE FILLED WITH A ~~50/50 MIXTURE OF DOWTHERM ETHYLENE GLYCOL AND WATER~~. Propylene
13. ALL DUCTWORK SHALL BE INSTALLED IN ACCORDANCE WITH SMACNA STANDARDS.
14. EXHAUST LOUVERS SHALL BE SIZED TO PREVENT MOISTURE ENTRAINMENT AND TO ALLOW NO MORE THAN 0.1" WG PRESSURE DROP.
15. TEMPERATURE CONTROLS SHALL BE ELECTRIC/ELECTRONIC AS REQUIRED TO PROVIDE A COMPLETE AND OPERABLE SYSTEM.
16. COORDINATE LOCATION AND HEIGHT OF ALL FINNED TUBE RADIATION AND LOCATIONS OF ELECTRICAL WALL OUTLETS.

REVISIONS	DATE	DESCRIPTION

STATE OF ALASKA 49TH — Dennis M. Bole — No. ME 3860 — REGISTERED PROFESSIONAL ENGINEER

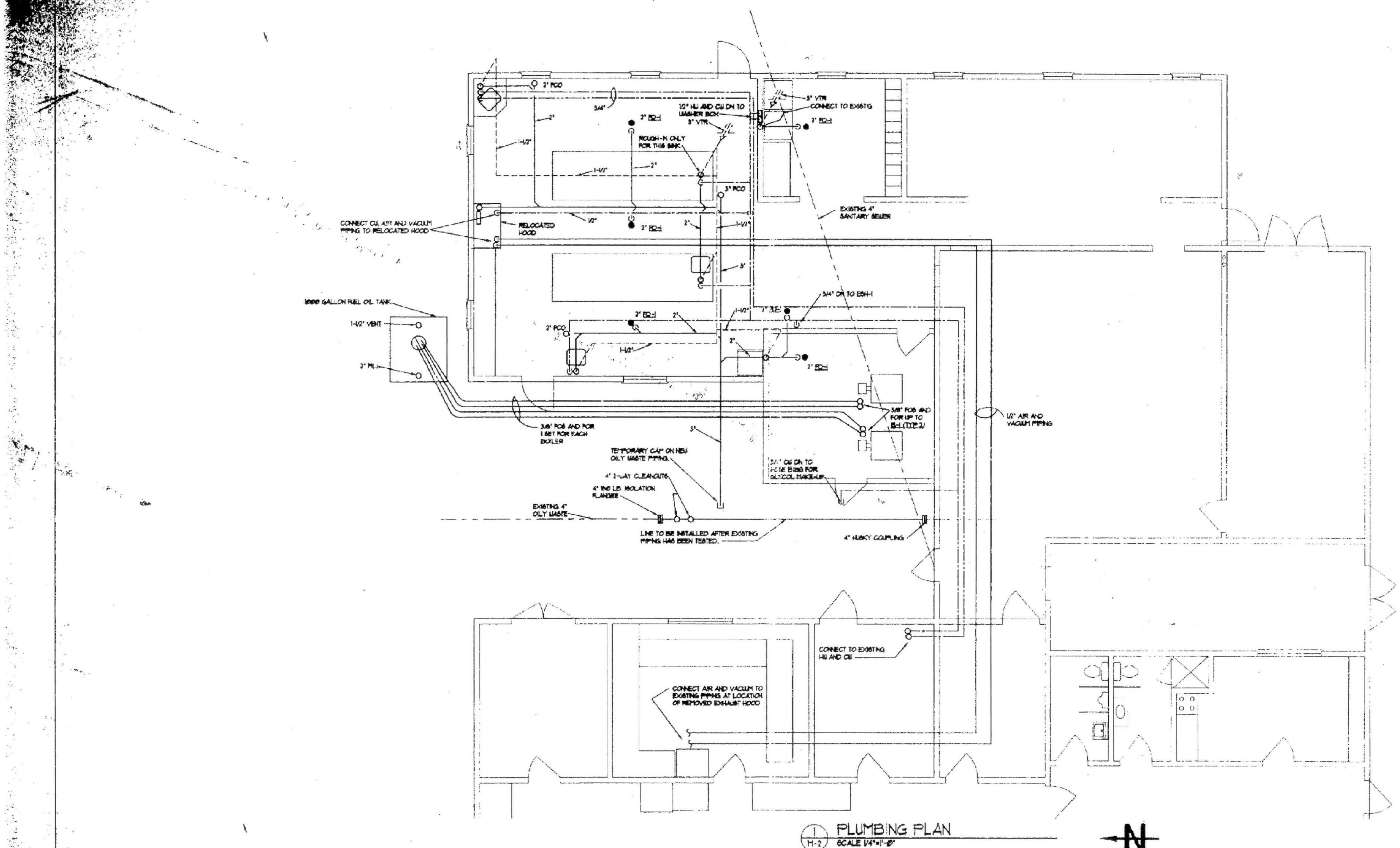
MAPCO REFINERY
LABORATORY EXPANSION

PROJECT 985 | DATE 6/15/98 | SCALE | DRAWN BY DB

SCHEDULE, SPECIFICATIONS, SCHEMATIC

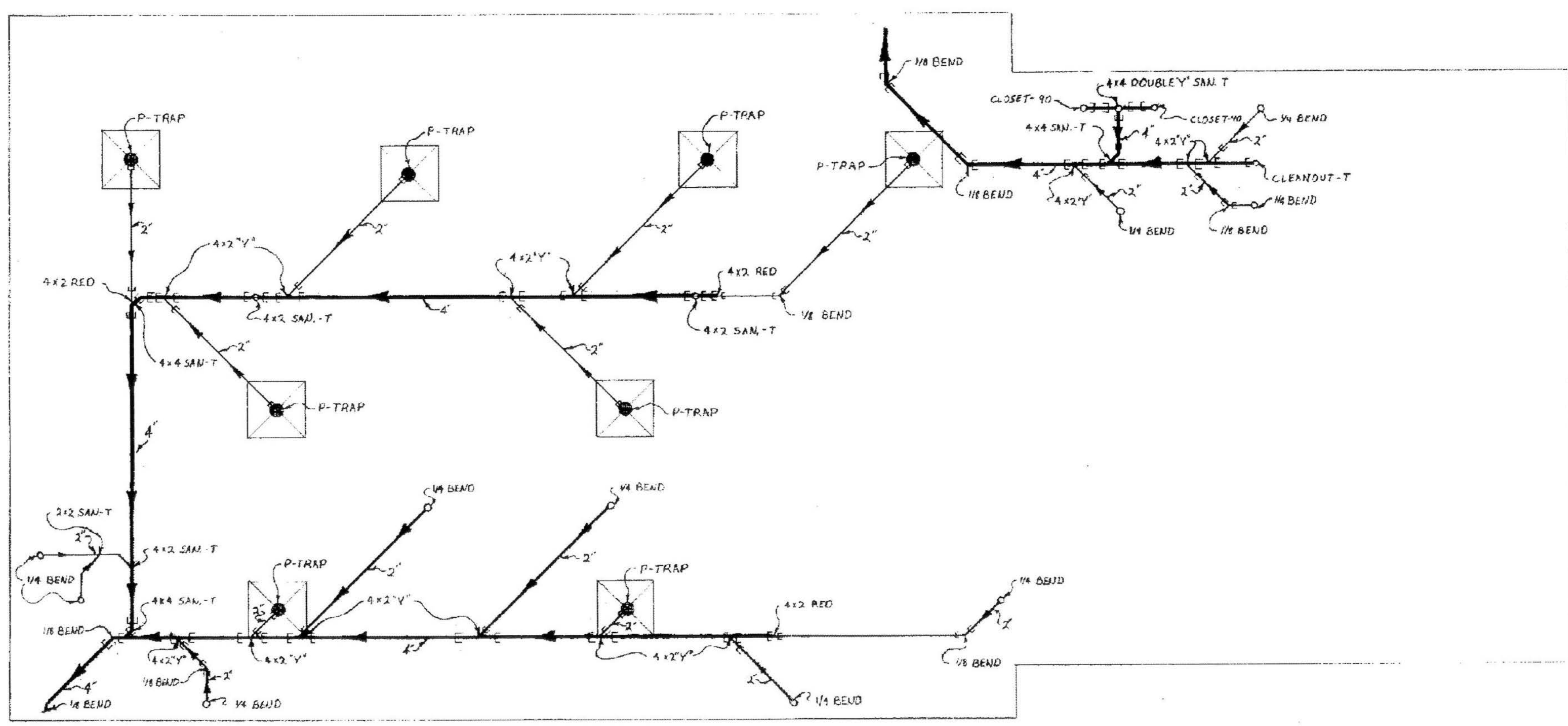
M-E-B ENGINEERING SERVICES
341 LIAMNA PL. FAIRBANKS, AK 99712 907-451-1946

M-1

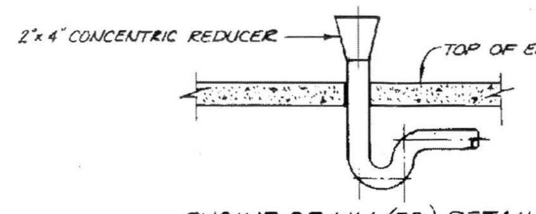


1/M-2 PLUMBING PLAN
SCALE 1/4"=1'-0"

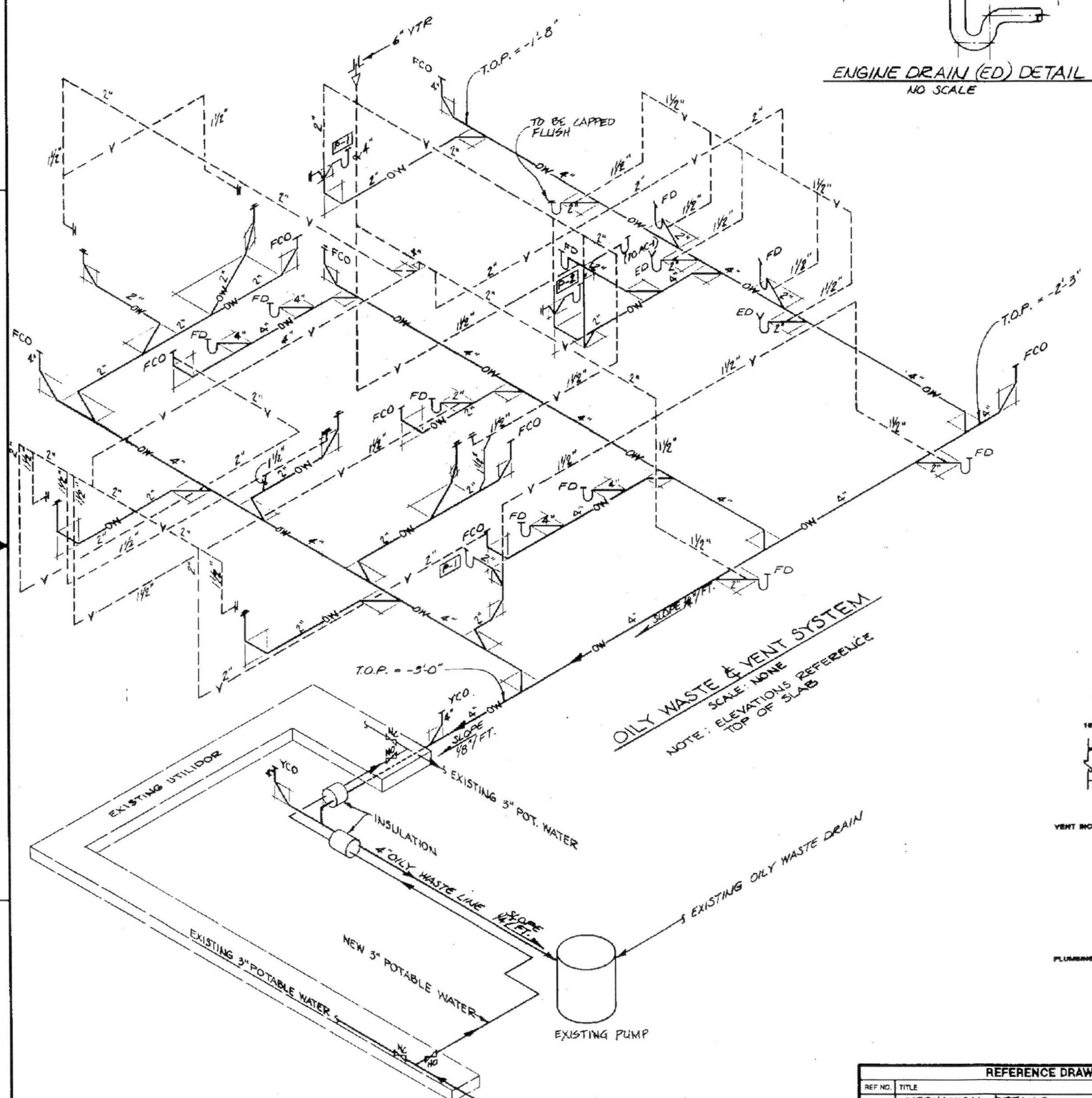
REVISIONS	DATE	DESCRIPTION	
STATE OF ALASKA 49TH Dennis W. Golz No. ME 3920 REGISTERED PROFESSIONAL ENGINEER		MAPCO REFINERY LABORATORY EXPANSION	
		PROJECT 9815	SCALE NOTED
		DATE 6/15/98	DRAWN BY DB
		PLUMBING PLAN	
		M-E-B ENGINEERING SERVICES	M-2



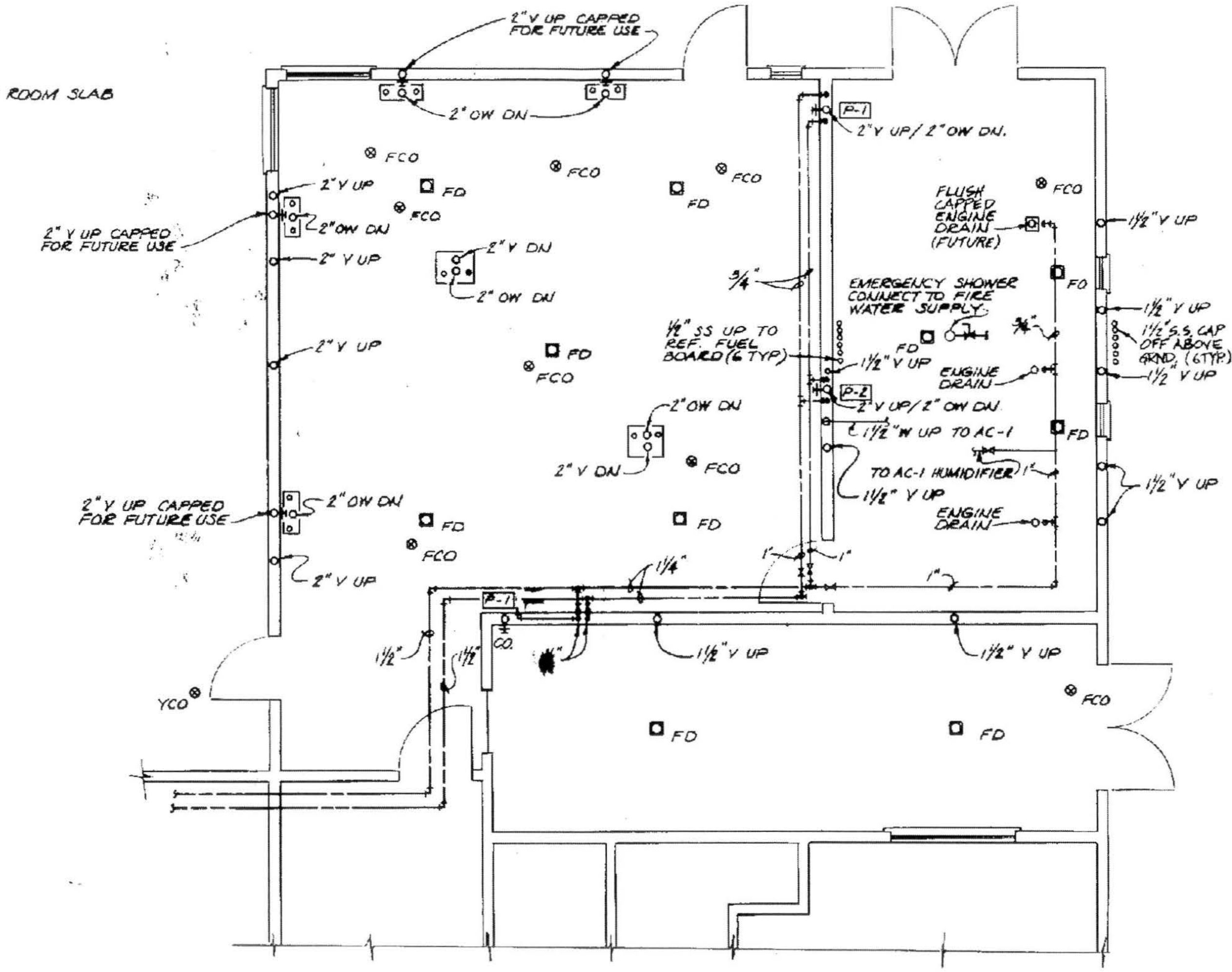
SCALE:	APPROVED BY:	DRAWN BY
DATE:		REVISED
PLUMBING LAYOUT		
		DRAWING NUMBER 118-3



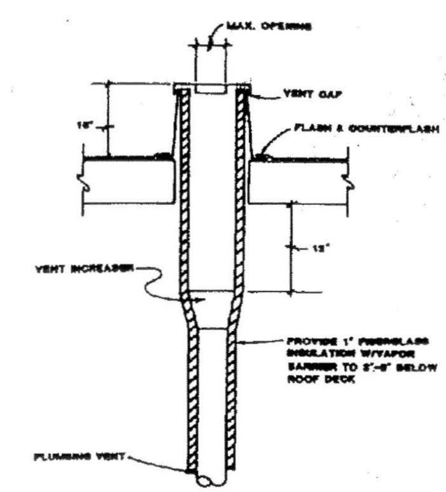
ENGINE DRAIN (ED) DETAIL
NO SCALE



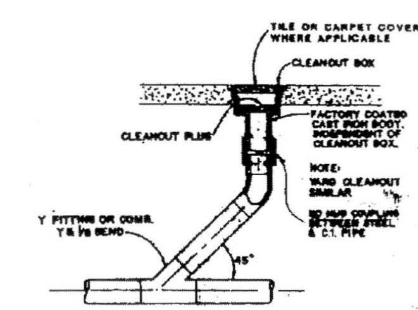
OILY WASTE & VENT SYSTEM
SCALE: NONE
NOTE: ELEVATIONS REFERENCE TOP OF SLAB



MAINLEVEL PLUMBING PLAN
SCALE: 1/4"=1'-0"



VENT THRU ROOF DETAIL
NO SCALE



CLEANOUT DETAIL
NO SCALE

SCANNED

REFERENCE DRAWINGS		
REF NO.	TITLE	DRAWING NO.
	MECHANICAL DETAILS	D-10-M1003
	UNDERGROUND PIPING PLAN	D-10-M1000

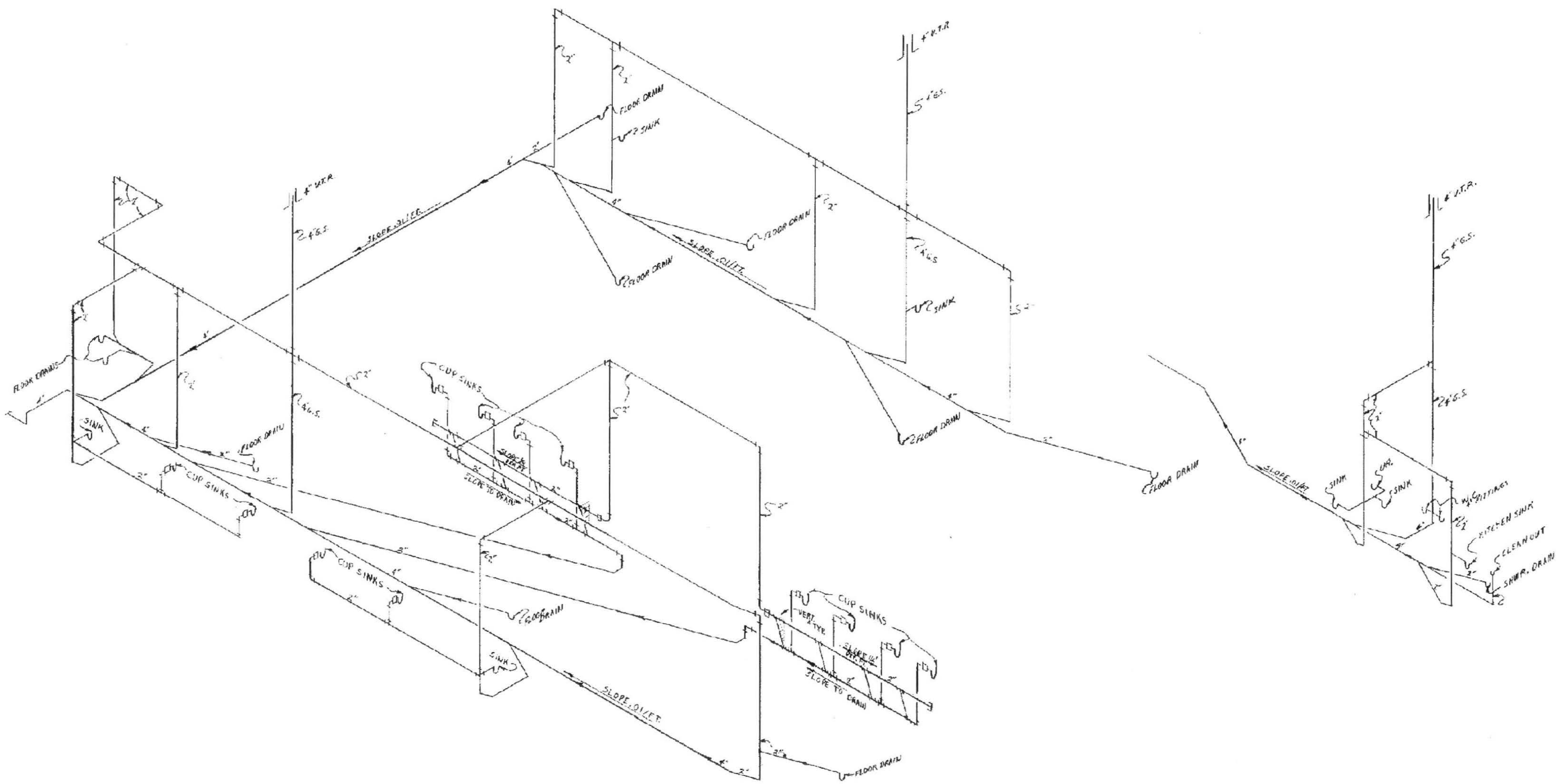
REVISIONS				
REV	DATE	BY	APPVD	DESCRIPTION
A	[illegible]	AL	WGT	ISSUED FOR APPROVAL
B	[illegible]	KS	DEC	ISSUE FOR CONSTRUCTION

ISSUE RECORD				
ISSUE NO	DATE	REV	TO	FOR

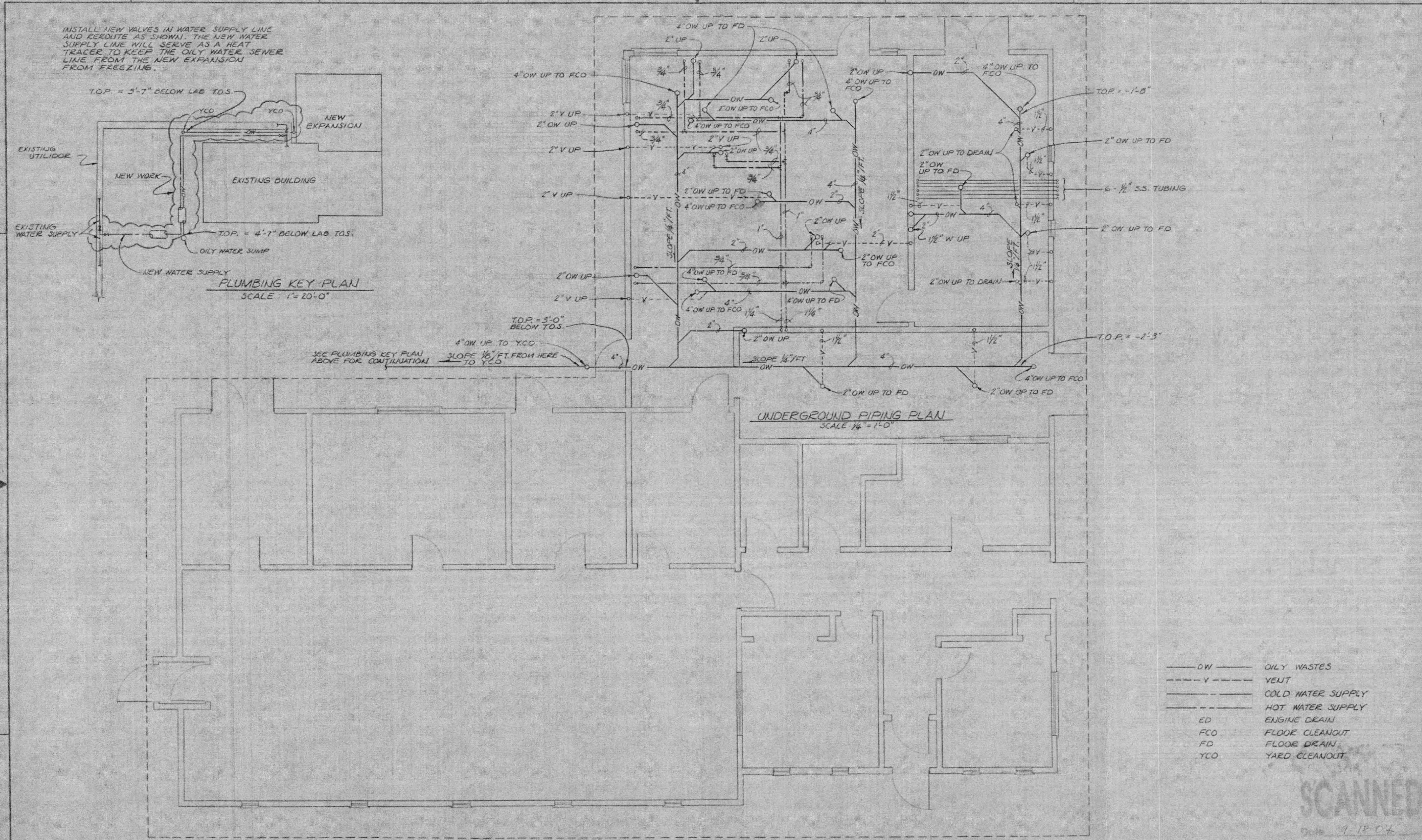
MAPCO INC.
MAPCO PETROLEUM INC.
NORTH POLE REFINERY
NORTH POLE, ALASKA

1985 LABORATORY EXPANSION
PLUMBING PLAN & DETAILS

PROJECT NO.: 13081-85E | SCALE AS SHOWN
PROJECT | DATE 4-2[illegible]
DRAWN [illegible]
DWG NO. D-10-M1001 | REV. 0 | CHECKED WGT



PLUMBING ISOMETRIC LAYOUT		
SCALE:	APPROVED BY:	DRAWN BY
DATE:		REVISED
LAB		
118-4		DRAWING NUMBER



STATE OF ALASKA 49TH Wesley G. Tomkins ME 5096 REGISTERED PROFESSIONAL ENGINEER

REFERENCE DRAWINGS		
REF NO.	TITLE	DRAWING NO.
	PLUMBING PLAN & DETAILS	D-10-M1001

REVISIONS				
REV	DATE	BY	APPVD	DESCRIPTION
A	4/25/85	AL	WGT	ISSUED FOR APPROVAL
0	5/85	PKS	DEL	ISSUE FOR CONSTRUCTION

ISSUE RECORD				
ISSUE NO.	DATE	REV	TO	FOR

MAPCO PETROLEUM INC.
NORTH POLE REFINERY
NORTH POLE, ALASKA

1985 LABORATORY EXPANSION UNDERGROUND PIPING PLAN

PROJECT NO. 13081-85E SCALE AS SHOWN
PROJECT
DATE 4-25-85
DRAWN AL
CHECKED WGT
DWG NO. D-10-M1000 REV. 0

Flint Hills Resources Alaska

NPR Laboratory Underground Piping Failure Evaluation

6/23/2010 Rev 0

7/21/10 Rev 1

STATE OF ALASKA
49TH
KENNETH R. BRUNE
EE - 9260
7/21/10
REGISTERED PROFESSIONAL ENGINEER

Table of Contents

I. Root Cause Analysis

A root cause analysis for the Flint Hills Resources Alaska (FHR), North Pole Refinery (NPR) laboratory drain piping was completed to determined the mechanism of failure on the lab sump drain piping. The root cause for the piping failure was found to be "Design not to Specification" on the drain piping connections at the time of installation in approximately 1985. This determination is based on a review of the original design information on the drain systems. The cast iron drain piping was put together during installation with No-hub style neoprene pipe couplings that are incompatible with certain hydrocarbons and can degrade when exposed to these hydrocarbons. See appendix A for building drain system drawings. See appendix B for chemical compatibility for Neoprene. Typical lab piping systems use Duriron high silicon cast iron piping and the appropriate couplings or glass piping systems manufactured by Corning or Kimax/Schott.

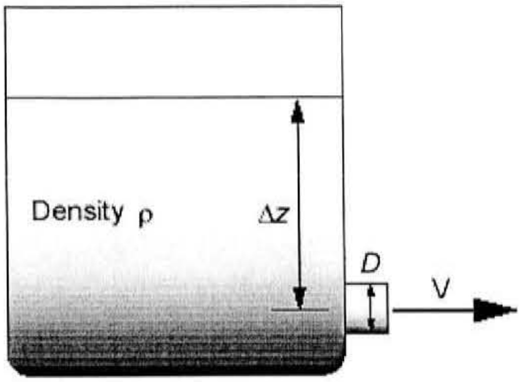
The piping drain systems were inspected by Keith Bradshaw from Fairbanks Pumping and Thawing on May 11, 2010. All of the piping drain systems are under the floor slab of the laboratory. Therefore, a flexiprobe P330 sewer camera was used to check the inside of the piping system. The flexiprobe camera was pushed inside of the piping system to the extent possible to inspect the piping internally for defects. The vertical sections of the piping was the only portion of the drain system which was clean enough to visually inspect with the camera. No-hub couplings in the area inspected were found to be deformed and in bad condition which would indicate leaking at the couplings inspected. See pictures in Appendix C.

II. Leak Rate Estimation

Objective: The objective of this section is to calculate the leak rate and the approximate leak orifice given the measured field data.

Background: A hydrostatic test using water was conducted on the under floor drain piping system at the NPR laboratory (lab) during the week of May 9th 2010. The underground drains were blinded and plugged at the outlet of the lab building. Water was used to fill the drain system liquid full. Air was removed by opening the cleanouts and observing the liquid level in all of the floor drains. When the water level reached the top of the floor drains, a timed test was started to measure loss of level over a given period of time. It was observed that the water level in the piping system dropped at a rate of 1 inch per hour. Measurements were taken with a tape measure at the top of the drain to the water level. Marks were made at the water levels with a paint pen to confirm the measurements.

Leak Rate Calculation



Given Burnoulli's equation for a small tank the combined equivalent leak orifice can be calculated.

$$\rho g z_{surface} + p_{atm} = \frac{1}{2}\rho V_{jet}^{2} + \rho g z_{spout} + p_{atm}$$

$$V_{jet} = \sqrt{2g\left(z_{surface} - z_{spout}\right)} = \sqrt{2g\Delta z}$$

$$Q = A_{jet}V_{jet} = CA_{spout}V_{jet}$$ [1],[2]

P = pressure V = velocity A = area of orifice C=nozzle constant p=density g=gravitational constant

Assumptions:

1) Pressure inside the drain pipe is the same as outside the drain pipe.
2) The piping system can be calculated as a small tank system
3) Orifice constant 0.9
4) Leaked fluid has low viscosity and is incompressible.

LEAK RATE CALCULATION

DRAINS	4	2	1.5	INCHES
TOTAL DRAINS	12	19	2	
DRAIN AREA	12.56637	3.141593	1.767146	INCHES^2
DRAIN HEIGHT	1	1	1	INCH
DRAIN VOLUME	12.56637	3.141593	1.767146	INCHES^3
TOAL DRAIN VOLUME	150.7964	59.69026	3.534292	INCHES^3

SUM OF DRAIN VOLUME	214.021	INCHES^3
GALLONS	0.926711	GALLONS
TEST DURATION	60	MINUTES
LEAK RATE	0.015445	GALLONS PER MINUTE

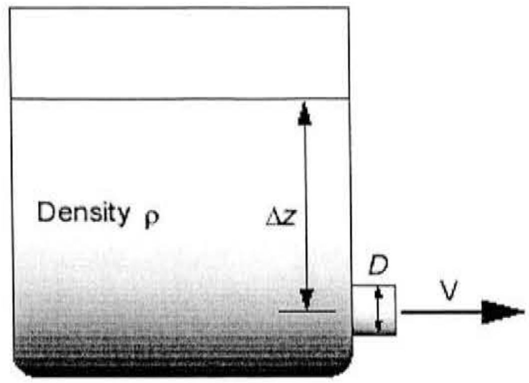
ORIFICE CALCULATION

0.9	CONSTANT K	
1	FT H2O	
0.000686	INCH SQ	ORIFICE AREA
0.029564	INCH ORIFICE DIAMETER	

References

1) Cameron Hydraulic Data, C.C. Heald Nineteenth Edition
2) www.efunda.com/formulae/fluids/draining_tank.cfm#calc

Calculation Back Check



Inputs

Depth of spout, Δz:	1	ft
Fluid density, ρ:	0.0361	lb/in^3
Spout exit diameter, D:	0.03	in
Discharge Coefficient, C:	0.9	

Answers

Exit Velocity, V:	8.02 ft/s	ft/s
Volume Flowrate:	0.0159 gal/min	gal/min
Mass Flowrate:	0.00221 lbm/s	lbm/s

Select desired output units for next calculation.

III. Chemical List

IV. Leak test description

The under floor drain piping system was plugged at the outlet of the building. Water was then used to fill the piping. The cleanouts were opened to make sure all of the air was removed from the drains. The piping system was then filled to the top of the drains. All of the drains were observed to verify full of water prior to beginning the test. A timed test was then completed. The leak rate was determined to be 1 inch per hour based on water loss of a specific period of time.

V. Summary

A root cause analysis was completed. The root cause for the piping system failure was determined to be incorrect design specifications at the time of installation in approximately 1985. Drawings were found that indicated No-hub style connectors were originally installed. Fairbanks Pumping and Thawing was used to investigate the condition of the inside of the piping. A sewer camera was used to look down inside the piping system. The No-hub connectors were found to be in poor condition. Naphtha and toluene are on the list of chemicals disposed of down the drain system and would have been disposed since installation first occurred. These chemicals are known to be aggressive toward neoprene. Leak rate calculations were completed. The approximate leak rate was found to be in the order of 0.015 gallons per minute or 21.6 gallons per day assuming liquid full for 24 hours. This leak rate is for a 100% full drain piping system and therefore is highly conservative. During normal operations the drain piping system would be intermittently used, would be open channel flow and not liquid full. The leak rate during normal use is affected by many variables like amount of time utilized and volume placed into the system so it cannot be calculated with any degree of accuracy. FHR has discontinued use and abandoned the lab drain piping system. A new temporary above ground steel piping system has been installed and is being added to the above ground piping inspection program. A long term project will be designed and installed at a later date.

Appendix A Lab piping drawings.

Appendix B Chemical compatibility for Neoprene

Chemical Compatibility Results Revise original search

The Material Selected **Neoprene**

Compatibility Level Selected **D-Severe Effect**

The chemicals which match your search results are listed below:

Chemical	Compatibility
Acetate Solvent	D-Severe Effect
Acetic Acid, Glacial	D-Severe Effect
Acetyl Chloride (dry)	D-Severe Effect
Alcohols:Diacetone	D-Severe Effect
Ammonium Bifluoride	D-Severe Effect
Amyl Acetate	D-Severe Effect
Amyl Chloride	D-Severe Effect

Aniline	D-Severe Effect
Aniline Hydrochloride	D-Severe Effect
Aqua Regia (80% HCl, 20% HNO3)	D-Severe Effect
Arochlor 1248	D-Severe Effect
Aromatic Hydrocarbons	D-Severe Effect
Asphalt	D-Severe Effect
Benzaldehyde	D-Severe Effect
Benzene	D-Severe Effect
Benzol	D-Severe Effect
Benzyl Chloride	D-Severe Effect
Bleaching Liquors	D-Severe Effect
Boric Acid	D-Severe Effect
Bromine	D-Severe Effect
Buttermilk	D-Severe Effect

Butyl Amine	D-Severe Effect
Butyl Ether	D-Severe Effect
Butyl Phthalate	D-Severe Effect
Butylacetate	D-Severe Effect
Butylene	D-Severe Effect
Butyric Acid	D-Severe Effect
Calcium Hypochlorite	D-Severe Effect
Carbolic Acid (Phenol)	D-Severe Effect
Carbon Bisulfide	D-Severe Effect
Carbon Disulfide	D-Severe Effect
Carbon Tetrachloride	D-Severe Effect
Carbon Tetrachloride (dry)	D-Severe Effect
Carbon Tetrachloride (wet)	D-Severe Effect
Carbonic Acid	D-Severe Effect

Chlorinated Glue	D-Severe Effect
Chlorine Water	D-Severe Effect
Chlorine, Anhydrous Liquid	D-Severe Effect
Chloroacetic Acid	D-Severe Effect
Chlorobenzene (Mono)	D-Severe Effect
Chlorobromomethane	D-Severe Effect
Chloroform	D-Severe Effect
Chlorosulfonic Acid	D-Severe Effect
Chromic Acid 10%	D-Severe Effect
Chromic Acid 30%	D-Severe Effect
Chromic Acid 5%	D-Severe Effect
Chromic Acid 50%	D-Severe Effect
Citric Oils	D-Severe Effect
Cream	D-Severe Effect

Cresols	D-Severe Effect
Cresylic Acid	D-Severe Effect
Cyclohexane	D-Severe Effect
Cyclohexanone	D-Severe Effect
Diacetone Alcohol	D-Severe Effect
Dichlorobenzene	D-Severe Effect
Dichloroethane	D-Severe Effect
Diethyl Ether	D-Severe Effect
Dimethyl Aniline	D-Severe Effect
Dimethyl Formamide	D-Severe Effect
Diphenyl Oxide	D-Severe Effect
Ether	D-Severe Effect
Ethyl Acetate	D-Severe Effect
Ethyl Benzoate	D-Severe Effect

Ethyl Ether	D-Severe Effect
Ethylene Chloride	D-Severe Effect
Ethylene Dichloride	D-Severe Effect
Ethylene Oxide	D-Severe Effect
Freonr 11	D-Severe Effect
Furan Resin	D-Severe Effect
Furfural	D-Severe Effect
Grape Juice	D-Severe Effect
Grease	D-Severe Effect
Hydrobromic Acid 100%	D-Severe Effect
Hydrobromic Acid 20%	D-Severe Effect
Hydrochloric Acid 100%	D-Severe Effect
Hydrofluoric Acid 100%	D-Severe Effect
Hydrofluoric Acid 50%	D-Severe Effect

Hydrofluoric Acid 75%	D-Severe Effect
Hydrogen Peroxide 10%	D-Severe Effect
Hydrogen Peroxide 100%	D-Severe Effect
Hydrogen Peroxide 30%	D-Severe Effect
Hydrogen Peroxide 50%	D-Severe Effect
Iodine	D-Severe Effect
Isopropyl Acetate	D-Severe Effect
Isopropyl Ether	D-Severe Effect
Isotane	D-Severe Effect
Jet Fuel (JP3, JP4, JP5)	D-Severe Effect
Ketones	D-Severe Effect
Lacquer Thinners	D-Severe Effect
Lacquers	D-Severe Effect
Lard	D-Severe Effect

Lubricants	D-Severe Effect
Maleic Acid	D-Severe Effect
Maleic Anhydride	D-Severe Effect
Malic Acid	D-Severe Effect
Melamine	D-Severe Effect
Methyl Acetone	D-Severe Effect
Methyl Bromide	D-Severe Effect
Methyl Butyl Ketone	D-Severe Effect
Methyl Chloride	D-Severe Effect
Methyl Ethyl Ketone	D-Severe Effect
Methyl Ethyl Ketone Peroxide	D-Severe Effect
Methyl Isobutyl Ketone	D-Severe Effect
Methyl Isopropyl Ketone	D-Severe Effect
Methyl Methacrylate	D-Severe Effect

Monoethanolamine	D-Severe Effect
Morpholine	D-Severe Effect
Naphtha	D-Severe Effect
Naphthalene	D-Severe Effect
Nitric Acid (20%)	D-Severe Effect
Nitric Acid (50%)	D-Severe Effect
Nitric Acid (Concentrated)	D-Severe Effect
Nitrobenzene	D-Severe Effect
Nitromethane	D-Severe Effect
Nitrous Acid	D-Severe Effect
Oils:Aniline	D-Severe Effect
Oils:Anise	D-Severe Effect
Oils:Bay	D-Severe Effect
Oils:Bone	D-Severe Effect

Oils:Citric	D-Severe Effect
Oils:Fuel (1, 2, 3, 5A, 5B, 6)	D-Severe Effect
Oils:Lemon	D-Severe Effect
Oils:Linseed	D-Severe Effect
Oils:Palm	D-Severe Effect
Oils:Peppermint	D-Severe Effect
Oils:Pine	D-Severe Effect
Oils:Sesame Seed	D-Severe Effect
Oils:Silicone	D-Severe Effect
Oils:Sperm (whale)	D-Severe Effect
Oils:Tanning	D-Severe Effect
Oils:Turbine	D-Severe Effect
Oleum 100%	D-Severe Effect
Oleum 25%	D-Severe Effect

Oxalic Acid (cold)	D-Severe Effect
Palmitic Acid	D-Severe Effect
Perchloroethylene	D-Severe Effect
Phenol (10%)	D-Severe Effect
Phenol (Carbolic Acid)	D-Severe Effect
Phosphoric Acid (crude)	D-Severe Effect
Phosphorus Trichloride	D-Severe Effect
Plating Solutions, Chromium Plating: Barrel Chrome Bath 95°F	D-Severe Effect
Plating Solutions, Chromium Plating: Black Chrome Bath 115°F	D-Severe Effect
Plating Solutions, Chromium Plating: Chromic-Sulfuric Bath 130°F	D-Severe Effect
Plating Solutions, Chromium Plating: Fluoride Bath 130°F	D-Severe Effect
Plating Solutions, Chromium Plating: Fluosilicate Bath 95°F	D-Severe Effect
Plating Solutions, Copper Plating (Misc): Copper (Electroless)	D-Severe Effect
Plating Solutions, Iron Plating: Ferrous Chloride Bath 190°F	D-Severe Effect

Plating Solutions, Nickel Plating: Electroless 200°F	D-Severe Effect
Propylene	D-Severe Effect
Pyridine	D-Severe Effect
Resorcinal	D-Severe Effect
Shellac (Orange)	D-Severe Effect
Styrene	D-Severe Effect
Sulfur Chloride	D-Severe Effect
Sulfur Dioxide (dry)	D-Severe Effect
Sulfur Trioxide	D-Severe Effect
Sulfur Trioxide (dry)	D-Severe Effect
Sulfuric Acid (75-100%)	D-Severe Effect
Sulfuric Acid (cold concentrated)	D-Severe Effect
Sulfuric Acid (hot concentrated)	D-Severe Effect
Tetrachloroethane	D-Severe Effect

Tetrachloroethylene	D-Severe Effect
Tetrahydrofuran	D-Severe Effect
Toluene (Toluol)	D-Severe Effect
Trichloroacetic Acid	D-Severe Effect
Trichloroethane	D-Severe Effect
Trichloroethylene	D-Severe Effect
Turpentine	D-Severe Effect
Urine	D-Severe Effect
Varnish	D-Severe Effect
Vinyl Acetate	D-Severe Effect
Vinyl Chloride	D-Severe Effect
Xylene	D-Severe Effect

Explanation of Footnotes

1. Satisfactory to 72°F (22° C)
2. Satisfactory to 120°F (48° C)

Ratings -- Chemical Effect

A = Excellent.

B = Good -- Minor Effect, slight corrosion
or discoloration.

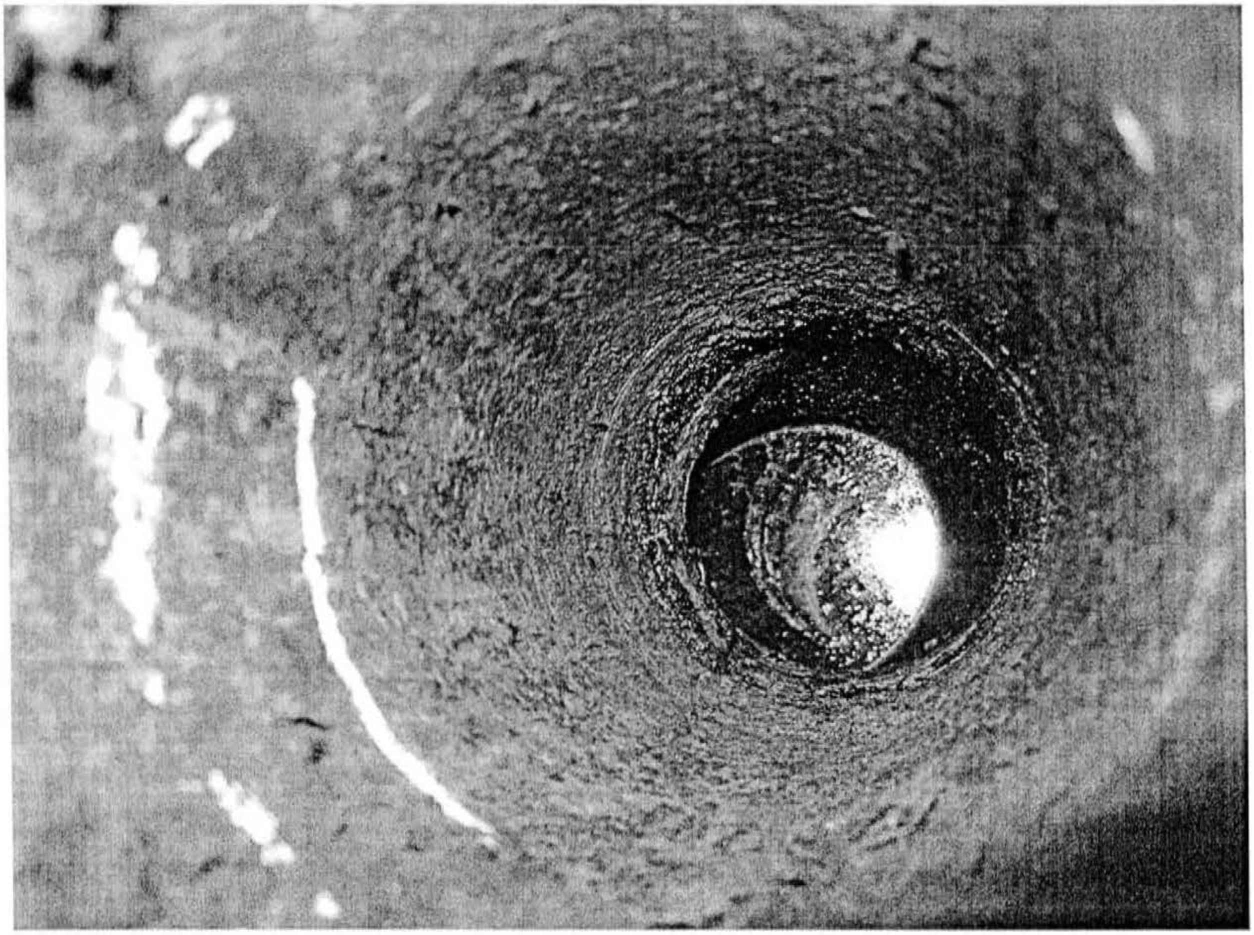
C = Fair -- Moderate Effect, not recommended
for continuous use. Softening, loss of strength,
swelling may occur.

D = Severe Effect, not recommended for **ANY** use.

N/A = Information Not Available.

Appendix C Drain pictures.

Picture 1. flexiprobe P330 used to view inside piping drain system.



Picture 2. Floor drain with deformed neoprene NO-HUB connector

Picture 3. Floor drain clean-out with neoprene NO-HUB connector

Appendix D Root Cause Map